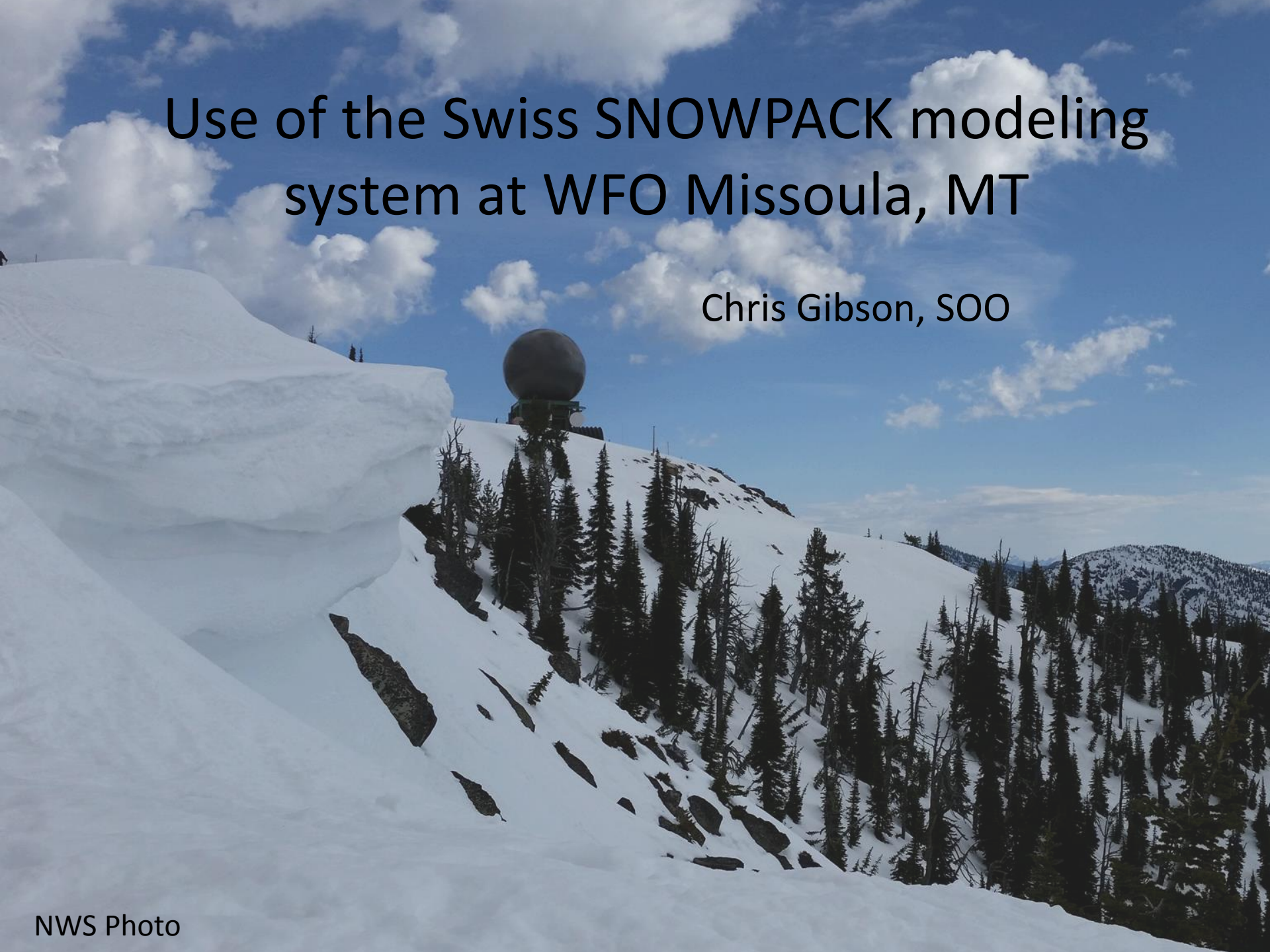
Use of the Swiss SNOWPACK modeling system at WFO Missoula, MT

Chris Gibson, SOO



NWS Photo

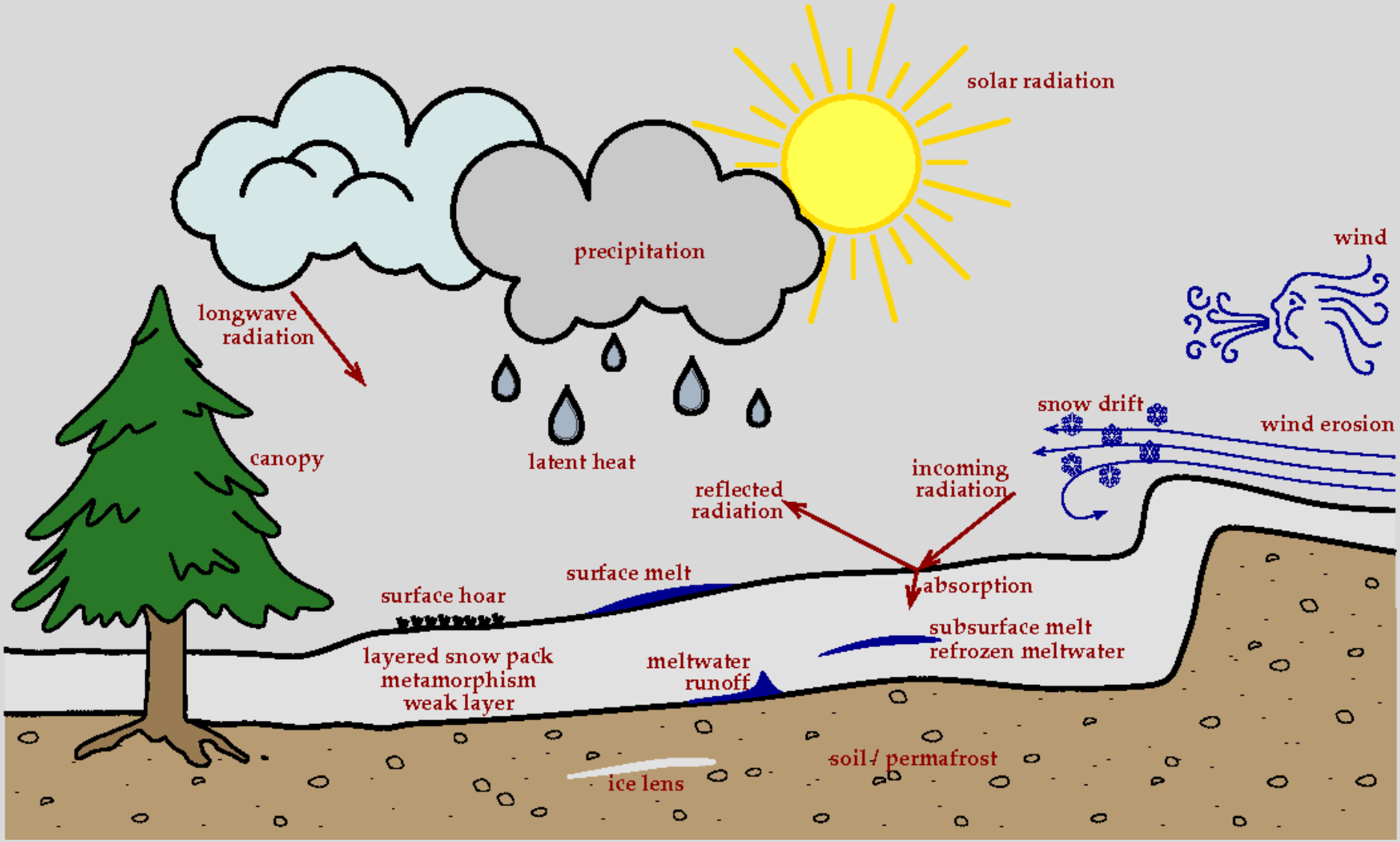
Swiss “SNOWPACK” Model

- One Dimensional Snow Model.
- Developed since the late 1990’s by the Swiss Institute for Snow and Avalanche Research – www.slf.ch
- Validated over a network of up to 100 weather stations across Switzerland.
- Numerically solves equations governing the mass, energy and momentum conservation within the snow pack.
- Uses- Avalanche Warning Programs, Ecology, Hydrology, Structural Engineering, Glaciology, Climatology and Ski Racing.
- https://models.slf.ch/p/snowpack/

<u>Early reference</u>

- Lehning, M., Bartelt, P., Brown, R.L., Russi, T., Stöckli, U., Zimmerli, M., *Snowpack Model Calculations for Avalanche Warning based upon a new Network of Weather and Snow Stations*, 1999, Cold Reg. Sci. Technol., **30**, 145-157.

Physical Processes

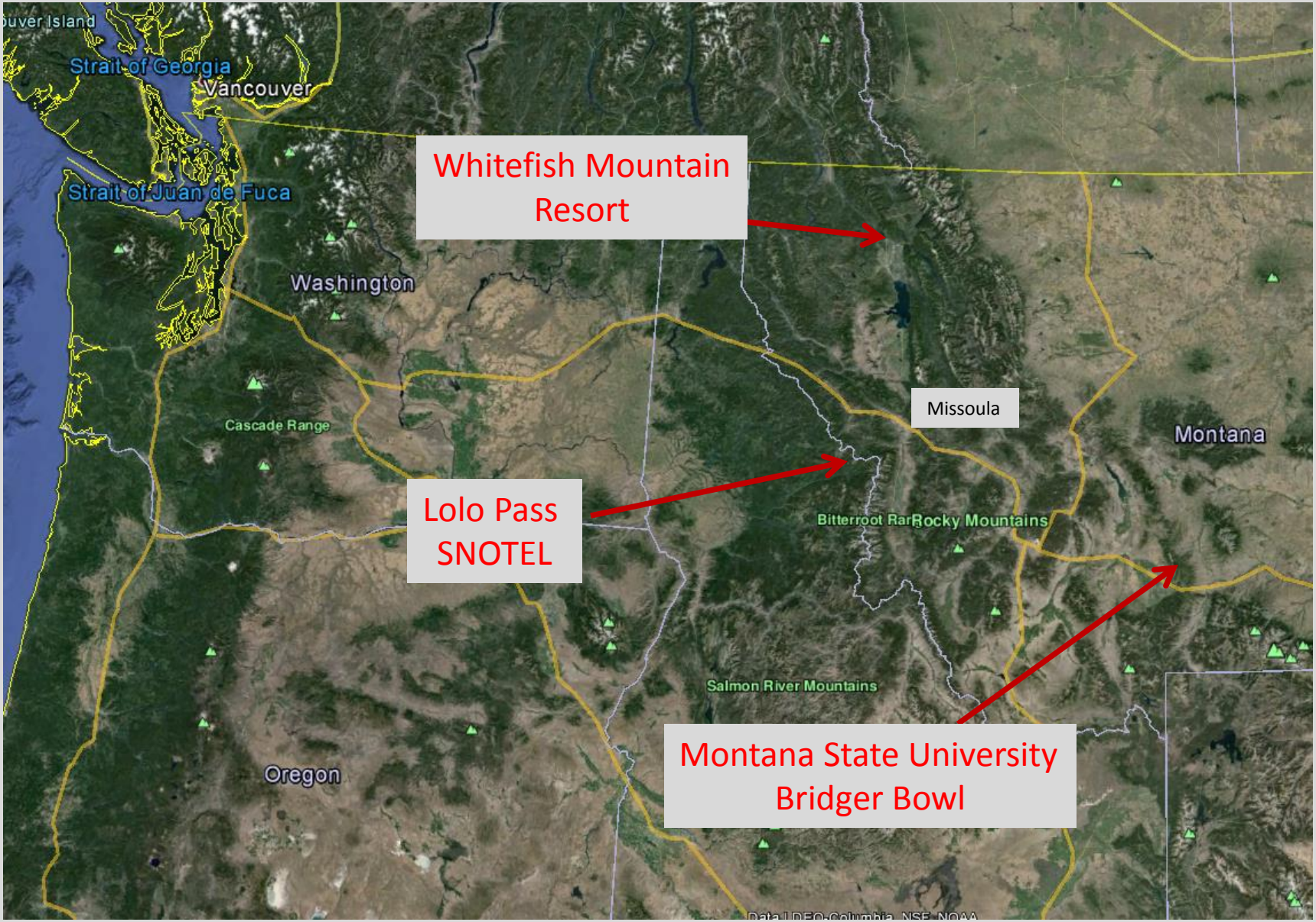


https://models.slf.ch/docserver/snowpack/html/general.html

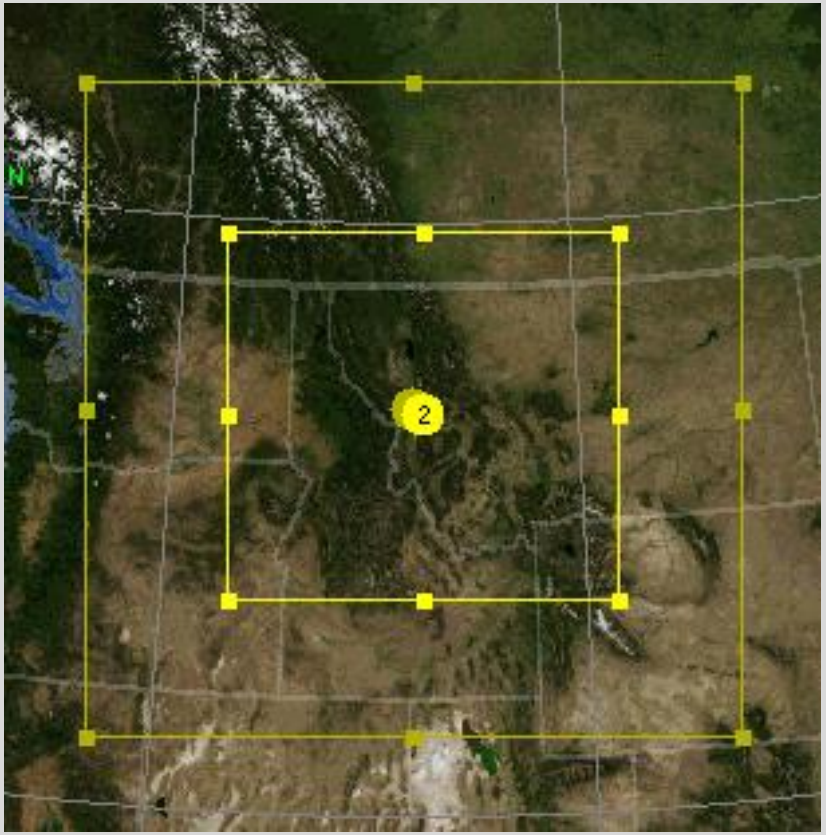
Meteorological Inputs (hourly)

- Air Temperature
- Relative Humidity
- Wind Speed
- Wind Gust
- Incoming/Outgoing Shortwave Radiation
- Incoming/Outgoing Longwave Radiation
- Precipitation
- Snow Surface Temperature

Snow Simulation Points



WRF-ARW Domain(s)



GFS 0.25 Degree → 9 KM → 3 KM Inner Nest

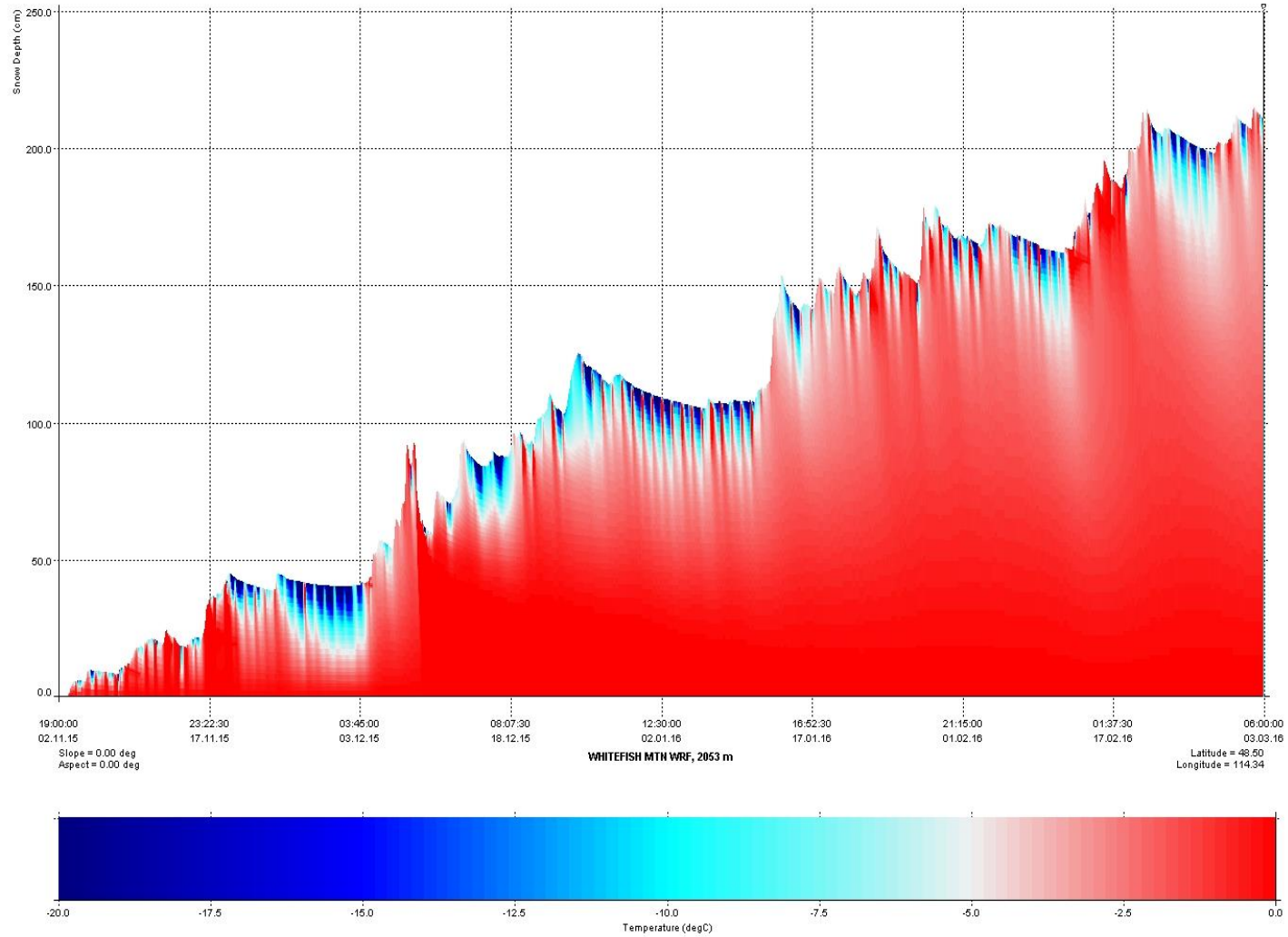
Configuration

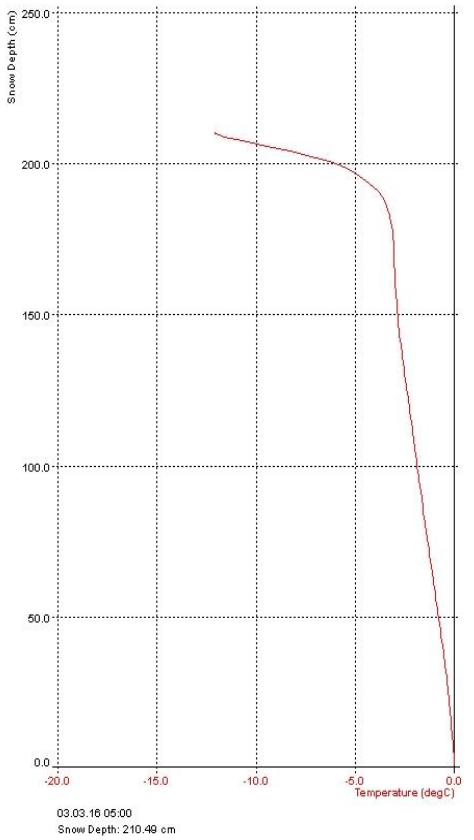
- No Cumulus parameterization for either nest
- Lin et al. microphysics
- Noah Land Surface Model
- 1-way nesting

Post-processing

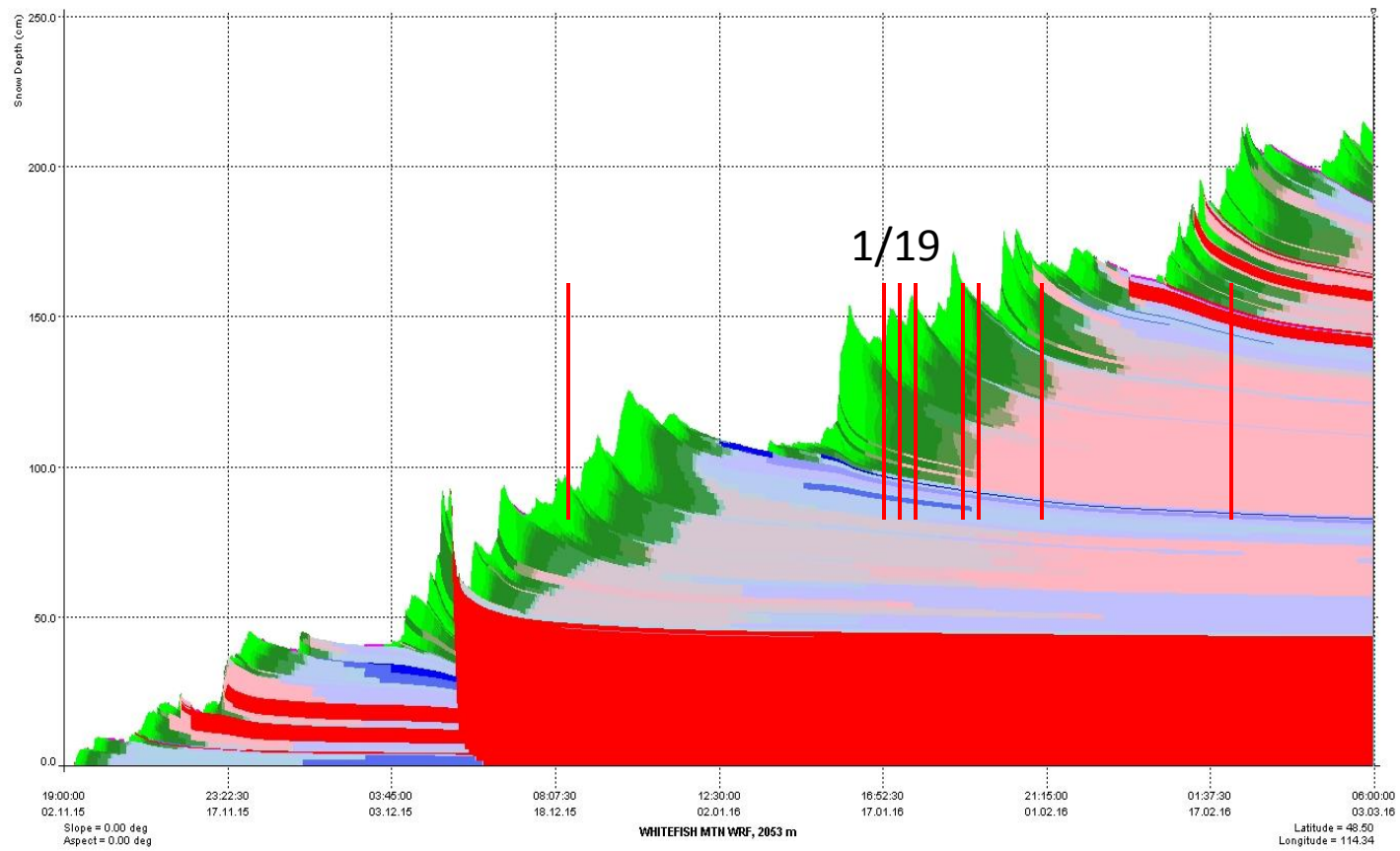
- Text files, BUFKIT, SNOWPACK format, AWIPS2

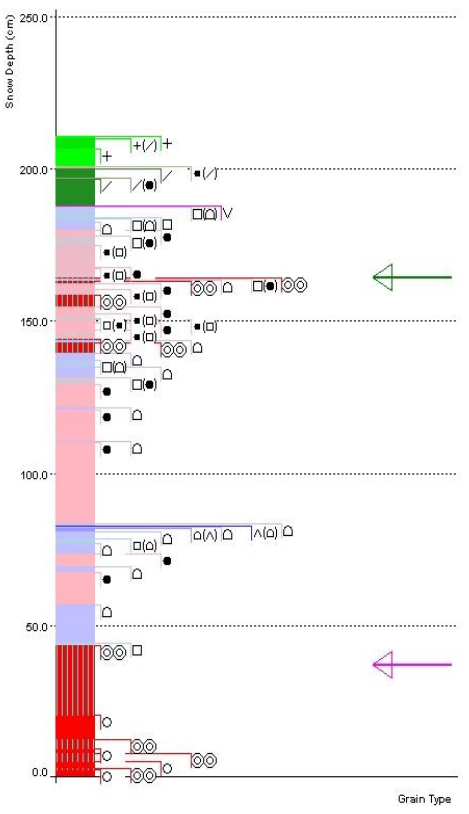
SNOWPACK results



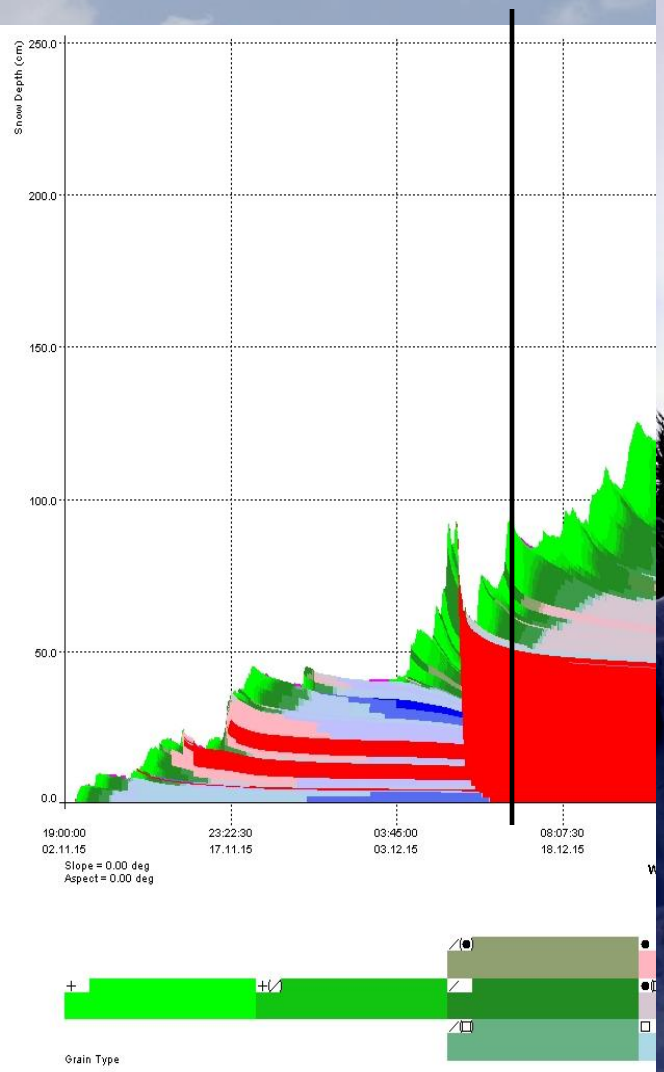


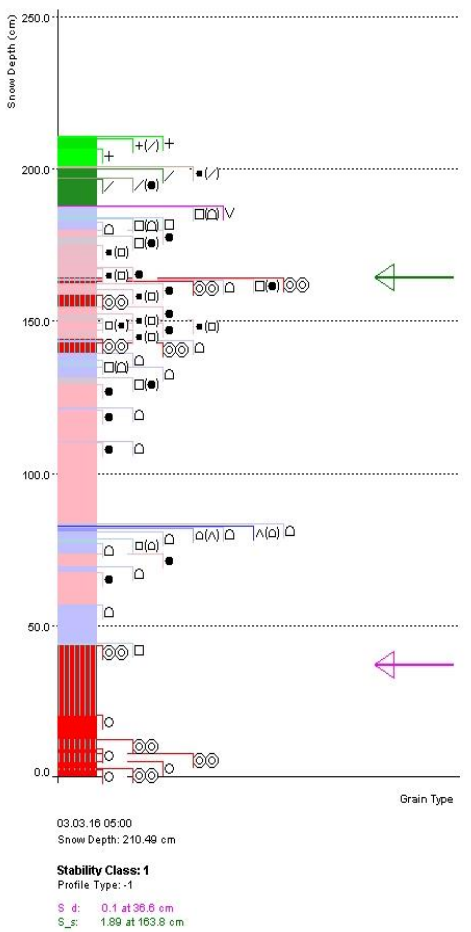
SNOWPACK Results





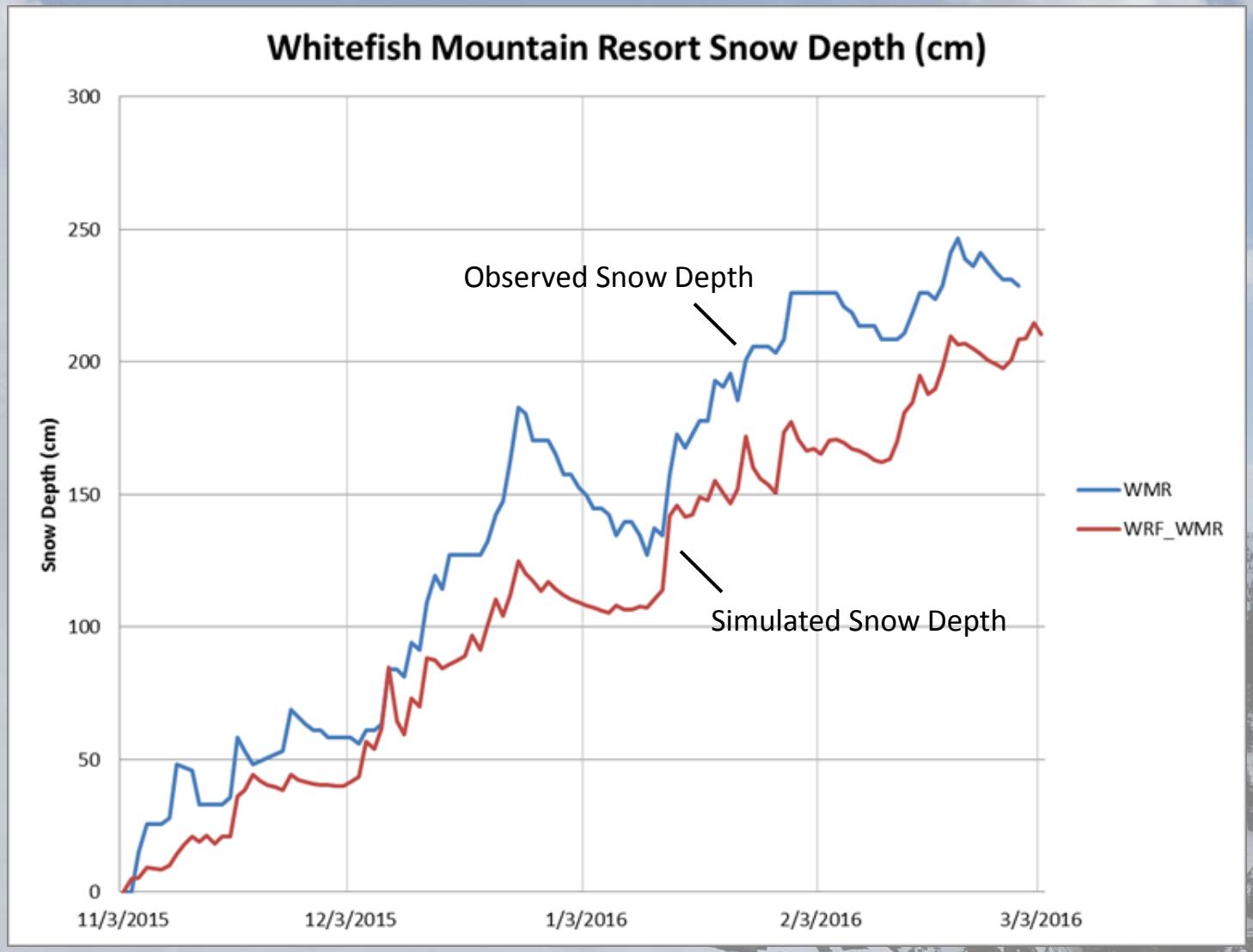
SNOWPACK Results



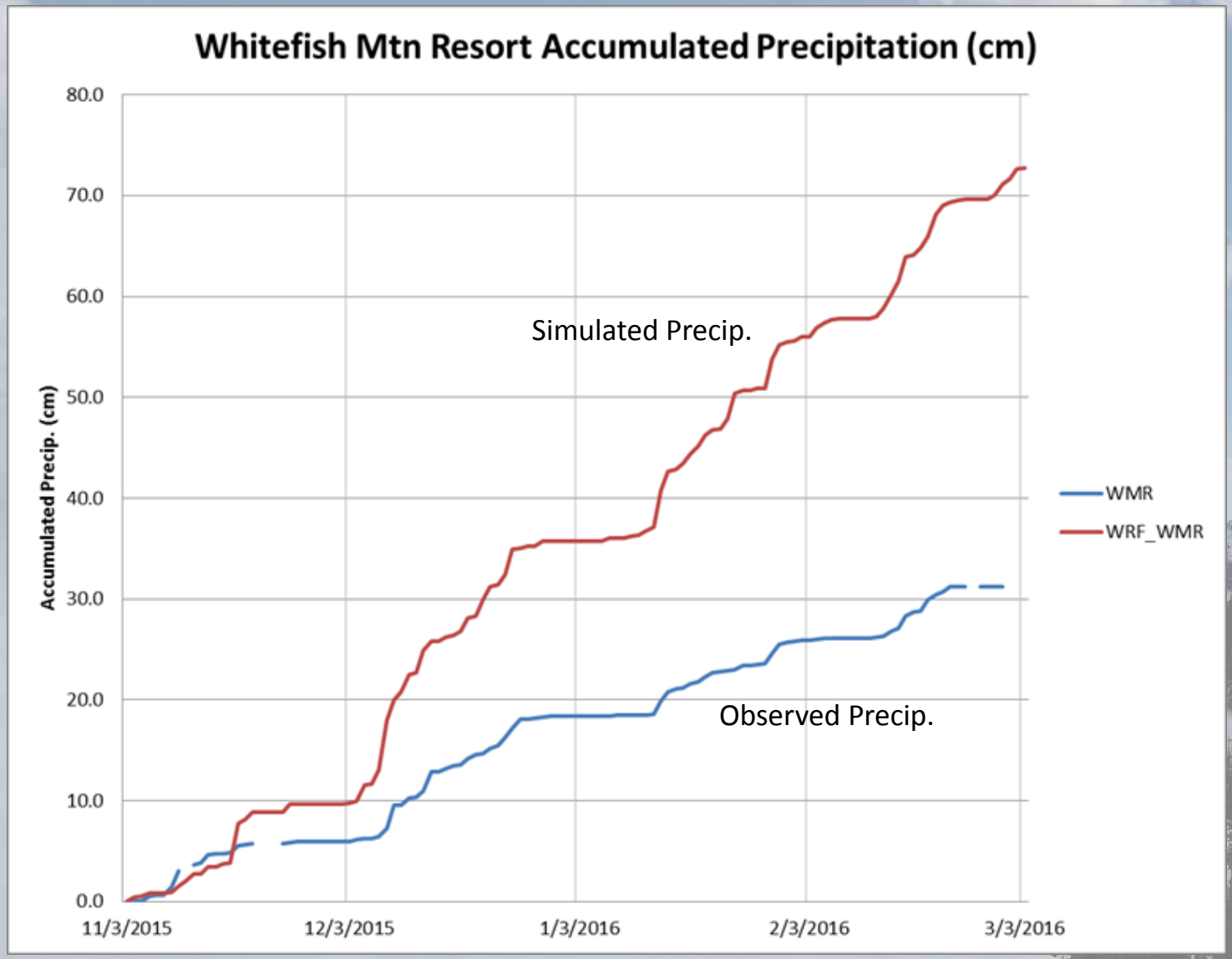


Courtesy Flathead Avalanche Center

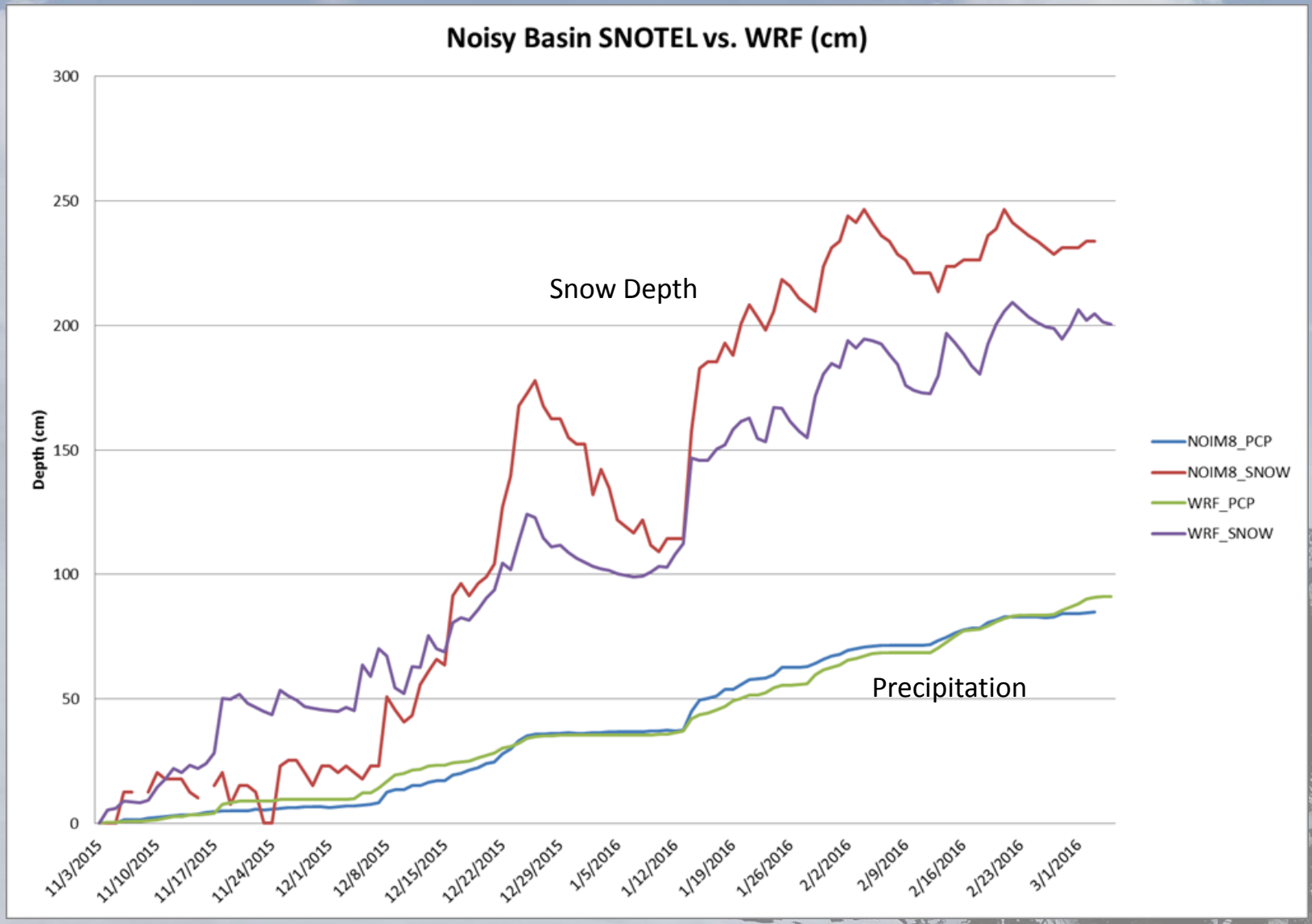
WRF Model vs. Obs for Whitefish



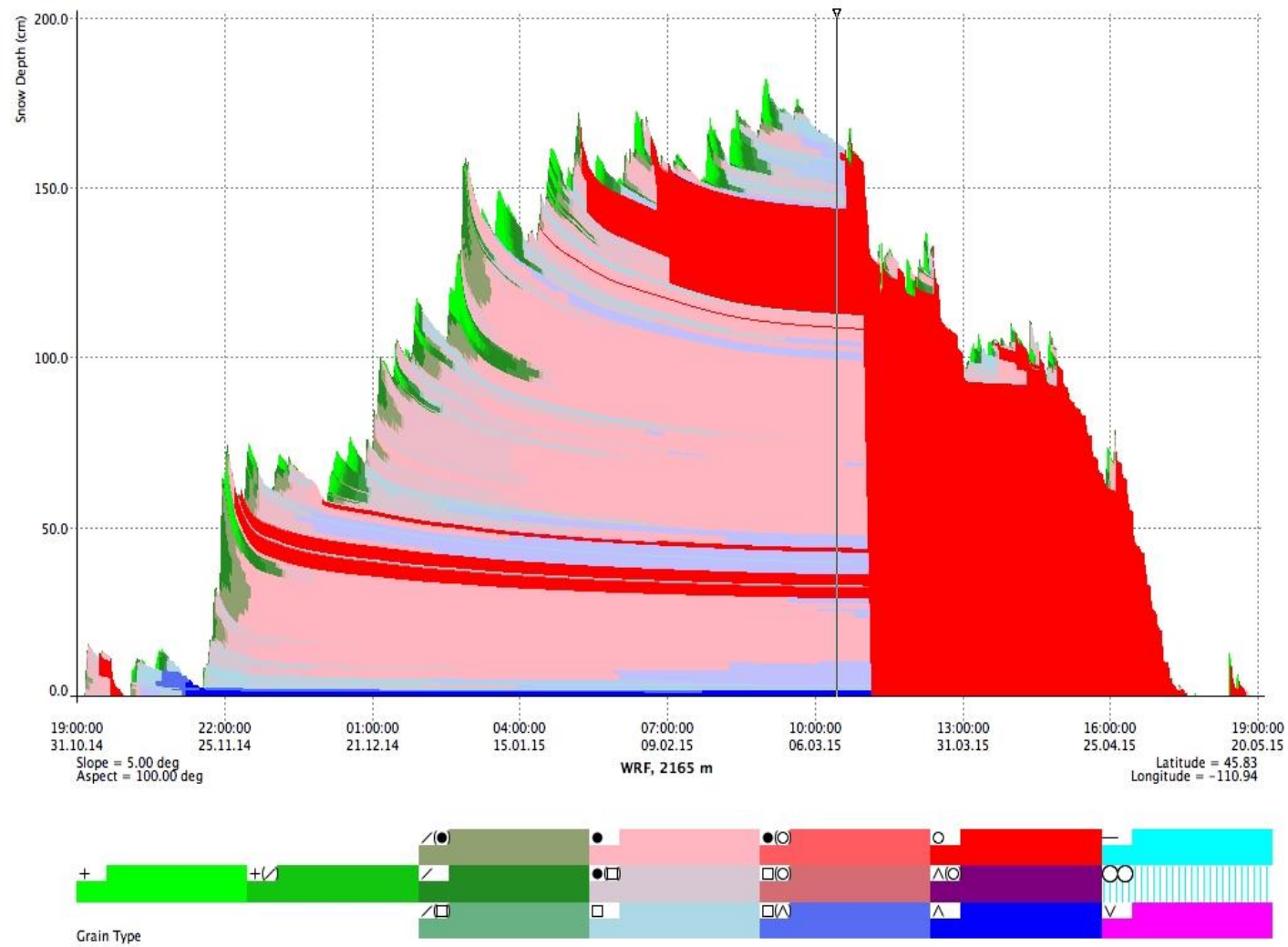
WRF Model vs. Obs for Whitefish

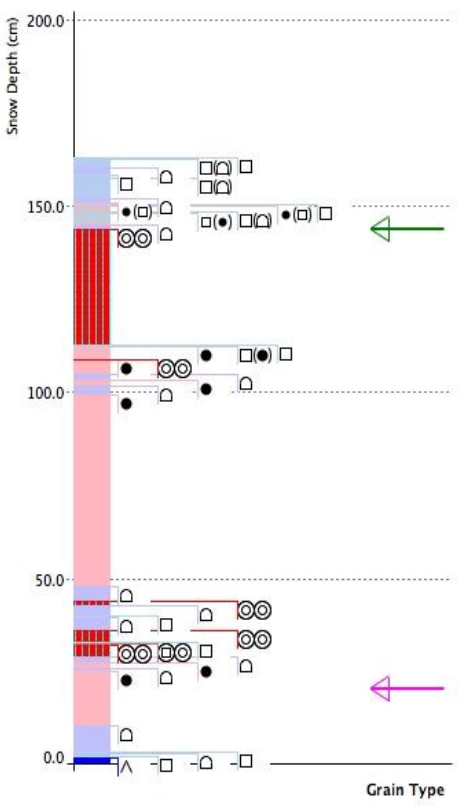


Noisy Basin SNOTEL Analysis



Bridger Bowl 2015





Conclusions

- WRF-ARW provided reasonable met. forecasts for remote mountainous areas.

- The SNOWPACK (driven by WRF-ARW) provided a reasonable depiction of the annual snow pack evolution in Western MT.

For the Missoula NWS Forecast Office SNOWPACK satisfied goals of:

- Scientific curiosity
- Increased forecaster awareness of weather impacts on the snow pack structure and avalanche implications
- Increased interaction with partners in the avalanche community
- Potential uses for runoff season (TBD)

SNOWPACK Results